III. "Extract from a Letter addressed by CHAS. BABBAGE, Esq., F.R.S., to Dr. BACHE, of Washington, May 10, 1852. Communicated by Mr. BABBAGE. Received November 26, 1868.

"In reading the account of the great solar eclipse of last year (1851) I was much struck by the description of the pink excrescences apparently attached to the sun's disk, and connected with its spots (see Proceedings of Royal Astronomical Society). They are only visible during a few minutes in a total eclipse. It occurred to me that it might be possible to render them visible at other times by two different methods:—

"1st. By placing in the focus of an equatorial telescope moved by clockwork an opake disk, equal to or a little larger than the sun's image. This would represent a continuous total eclipse; and if every known means of excluding light were adopted, it might be possible to see those faint pink objects, which are probably clouds raised by the eruption of solar volcanoes.

"2nd. If this fail, it might yet be possible to render them visible by taking daguerreotype or photographic images.

"It is really surprising that nobody has yet taken such images regularly, for the sake of recording the solar spots and their changes.

"I have no clock-moving equatorial myself fit for these observations, nor have I time to spare for them.

"I cannot persuade my countrymen that they are important, so you are at liberty to try them, or publish the plan on your side of the Atlantic.

"Mr. Gould will probably have explained to you an old plan of mine for mapping zones of stars without moving the eye from the telescope."

November 30, 1868.

ANNIVERSARY MEETING.

Lieut.-General SABINE, President, in the Chair.

Mr. Newmarch, on the part of the Auditors of the Treasurer's Accounts appointed by the Society, reported that the total receipts during the past year, including a balance of £495 10*s.* 3*d.* carried from the preceding year, amount to £4780 5*s.* 11*d.*; and that the total expenditure in the same period amounts to £4286 11*s.* 5*d.*, leaving a balance of £479 16*s.* 1*d.* at the Bankers', and of £13 18*s.* 5*d.* in the hands of the Treasurer.

The thanks of the Society were voted to the Treasurer and Auditors.

The Secretary read the following Lists:—

Fellows deceased since the last Anniversary.

Royal.

His Imperial and Royal Highness the Archduke Louis of Austria (1864).

On the Home List.

Charles Dickson Archibald, Esq.
Charles James Beverly, Esq.
Capt. Benjamin Blake*.
Rev. Miles Bland, D.D.
Sir David Brewster, K.H., LL.D., D.C.L.
Henry, Lord Brougham and Vaux, M.A.
Rev. Jonathan Cape.
Robert John, Lord Carington.
Antoine François Jean Claudet, Esq.
The Right Hon. Sir George Clerk, Bart., D.C.L.
John Crawfurd, Esq.
Charles Giles Bridle Daubeny, M.D., LL.D.
John Davy, M.D.
Rev. William Rutter Dawes.
George Douglas, Esq. (1853).
Sir William Francis Eliott, Bart. (1864).
John Elliotson, M.D.
The Right Hon. Sir Edmund Walker Head, Bart.
William Bird Herapath, M.D.
Sir Charles Lemon Bart.
Sir John Liddell, K.C.B., M.D.
John Carnac Morris, Esq.*
Rev. Henry Noel-Fearn, M.A., D.C.L.
Robert Porrett, Esq.
Archibald John, Earl of Rosebery, K.T., M.A., LL.D.
The Ven. Archdeacon Tattam, D.D.
Thomas Pridgin Teale, Esq.
Nathaniel Bagshaw Ward, Esq.
Alexander Luard Wollaston, M.B*.

On the Foreign List.

Marie Jean Pierre Flourens.
Jean Bernard Léon Foucault.
Julius Plücker.
Jean Victor Poncelet.

Withdrawn.

Rear-Admiral Thomas Edward Lawes Moore.

Defaulters.

Sir John Macneill.
Edward Solly, Esq.
The Right Hon. Charles Pelham Villiers.

Fellows elected since the last Anniversary.

John Ball, Esq., M.A.
Henry Charlton Bastian, M.D.
Lieut.-Col. John Cameron, R.E.
Prof. Robert Bellamy Clifton, M.A.
Morgan William Crofton, Esq., B.A.
Joseph Barnard Davis, M.D.
Peter Martin Duncan, M.B.
John Peter Griess, Esq.
Augustus G. Vernon Harcourt, Esq.
Rear Ad. Astley Cooper Key, C.B.
Rear-Admiral E. Ommanney, C.B.
James Bell Pettigrew, M.D.
Laurence Parsons, Earl of Rosse.
Edward James Stone, Esq., M.A.
Rev. Henry Baker Tristram, M.A.
Wm. S. Wright Vaux, Esq., M.A.

On the Foreign List.

Theodor Ludwig Wilhelm Bischoff.
Rudolph Julius Emmanuel Clausius.
Hugo von Mohl.
Samuel Heinrich Schwabe.

Readmitted.

Colonel John Le Couteur.

* Date of decease unknown.

The President then addressed the Society as follows:—

GENTLEMEN,

I HAVE the satisfaction of now laying before you the second volume of the Catalogue of Scientific Papers. The volume now completed carries on the list of titles in alphabetical order as far as GRA, inclusive. The Library Committee, under whose superintendence the Catalogue is published, had hoped that the printing of the work would have made greater progress than it has done during the time that has elapsed since the appearance of the first volume; but notwithstanding their earnest endeavours to attain that object, they found that, with due regard to the careful revision of the press, the rate of printing could not be materially accelerated.

In fulfilment of the understanding with Her Majesty's Government, explained in my Address last year, copies have been presented to various Scientific Institutions and individuals, according to a list drawn up by the Council, and approved by the Treasury. It is gratifying to know that in the numerous letters of acknowledgment received in return, as well as more publicly through the press, the value of the work as an aid to scientific research has been warmly recognized. As a special instance of this favourable expression of opinion, I would refer to the ample notice of the book written by our Foreign Member, Hofrath W. Ritter v. Haidinger, of Vienna, and circulated by him in different parts of Europe.

Already of the remaining copies 120 have been sold.

My last year's Address contained an account of the proceedings of the Committee of the Royal Society, which, at the request of Her Majesty's Government, had undertaken the reorganization and superintendence of the meteorological department of the Board of Trade. The year that has since elapsed has been employed, 1°, In perfecting the instrumental arrangements, and the systematic working of the staff, at the seven British Observatories which have been supplied, under the Committee's direction, with continuously self-recording meteorological apparatus. For this purpose one or more of the staff of each Observatory has passed some days at the Central Observatory at Kew; and the Observatories themselves have been visited, some by Mr. Scott, the Director of the Meteorological Office in London, and all by Mr. Stewart, the Superintendent of the Central Observatory, and also by Mr. Beckley, the Engineer of the Kew Establishment. By these means it is hoped that uniformity of action on thoroughly well considered principles has been secured, and a considerable advance made towards the systematic record of the meteorological phenomena over the British Islands. The monthly records are now beginning to be received at the Office in London with regularity from all the Observatories, but have scarcely yet quite attained in all instances to that uniform accuracy which it is hoped will be fully secured at the close of the present

year. The means and the methods by which the facts thus considerately and systematically obtained may be communicated to the public, in the form which may be at once suitable for the study of the weather phenomena over the very limited territorial area of the British Islands—and may at the same time contribute in the most satisfactory manner to the important investigations which are now in progress on the Continent of Europe regarding the periodic and non-periodic variations—will be the next point to which the careful attention of the Committee will be directed.

2°. In the branch of ocean meteorology the cooperation of several of our leading oceanic steam companies has been secured; and a large number of the commanders of their vessels are now actively engaged in the work of observing. Instruments have also been supplied to other masters of vessels of our mercantile marine, care being always taken that the recipients are both competent to observe and willing to do so regularly and accurately. The zeal and judgment displayed by Captain Henry Toynbee, the Marine Superintendent of the Office, in the selection of observers, has already begun to bear fruit in the marked improvement in the quality of the information in the registers which are now received compared with those which had previously accumulated in the office. The discussion of the material which has been thus collected and is still collecting is in progress; but some time must elapse before a significant portion of the immense arrear can be advanced to such a stage as to afford a prospect of its speedy publication. The staff of clerks is already fully occupied; so that the rate of progress cannot be much accelerated, unless the Committee find themselves in a position to devote more funds to this object than they are at present able to do. The special subject to which the attention of this department of the office has been first directed, is the discussion of information respecting the district of the Atlantic Ocean comprised between the parallels of 20° N. and 10° S., for which region it is in contemplation to ascertain the conditions of atmospheric pressure, temperature, and vapour tension, as well as the direction and force of wind, the character of the weather, and the surface temperature of the sea. These elements will be discussed for spaces of a single square degree in area for the different months.

As regards the temperature of the surface of the sea (a subject so much dwelt on by the President and Council of the Royal Society in their letter to the Board of Trade of February 22, 1855), a very valuable series of monthly charts has been published by the Royal Meteorological Institute of the Netherlands, exhibiting the temperature for each degree of latitude for the North and South Atlantic Oceans, and for the Indian Ocean. The Committee considered that a conversion of the data in these charts into British measures would be likely to be of immediate use to our own marine, and they have accordingly directed that a set of charts should be prepared in the first instance for the South Atlantic Ocean, exhibiting the Dutch results, as well as those obtained from the British registers received by the meteo-

rological department of the Board of Trade under its former management. These latter, however, were only calculated for spaces of five degrees square. In addition, some of the work left in an unfinished state by Admiral Fitz Roy has been undertaken by the office at extra hours, and a series of wind-tables for the Atlantic have been ordered to be printed. The discussion of general meteorological information for the Pacific seaboard of South America is in a state far advanced towards completion.

3°. The system of telegraphic weather-intelligence, described in my last year's anniversary address, has received a further development, and at present the Drum signal is hoisted at 97 British stations, to convey the intelligence of the existence of atmospherical disturbance in each case to such ports as may appear to the central office to be reasonably liable to be affected by it. Similar intelligence has been telegraphed to Hamburg since February 1868; and in the course of last month Herr von Freeden, the Director of the newly established meteorological office in that city (the Nord-deutsche Seewarte), has informed the London office that the harbour authorities on the Elbe have resolved to hoist the Drum signal at Hamburg and Cuxhaven whenever intelligence implying probable danger shall be received from London. In France also the ministry of the marine has adopted, for the present at least, the practice of telegraphing facts and not prophecies.

In addition to the telegraphic communications already referred to, the London Office sends, by special request, telegraphic intelligence of the existence of a certain amount of difference of barometric pressure between two stations within a defined area, to Mr. Rundell (Secretary of the Underwriters' Association at Liverpool), and to the Dutch authorities. The influence which the distribution of atmospheric pressure exerts on the motion of the air has been much dwelt upon by Dr. Buys Ballot, of Utrecht, and a rule has beeu propounded by him for inferring the coming direction of the wind from simultaneous readings of the barometer at different places. In order to lay the foundation of a systematic study of our weather, and, at the same time, to test the truth of this rule, it has been the practice of our meteorological office, for more than a year past, to prepare, and subject to systematic discussion, daily charts of the meteorological condition over the area embraced by the daily telegraphic reports which it receives, viz. the British Islands and a portion of the nearer continental coasts. The results of this investigation are on the whole encouraging, and favour the hope that with a more extended experience a real, if slight, advance will have been made in this most intricate but interesting inquiry.

The magnificent but rare phenomenon of a total solar eclipse is not more striking as a spectacle than interesting in a scientific point of view, from the precious opportunity it affords of gathering information, then only to be obtained, which bears on the constitution of our great luminary. The corona which surrounds the dark body of the moon must have

been seen from the earliest times; but what does it import? Has it its seat in our own atmosphere, or in an atmosphere of the moon, or in something surrounding the sun? and, in the latter case, is it self-luminous, or does it shine by reflected light? What, again, is the nature of those singular rose-coloured luminous objects seen just outside the dark disk of the moon, which were first brought prominently into notice by the observers who watched the eclipse of July 7, 1842, and have subsequently been seen on the occasion of total solar eclipses?

Evidence bearing in an important manner on the true answers to these questions had already been obtained on the occasion of former total eclipses. In that of July 18, 1860, M. Prazmouski ascertained that the light of the corona was strongly polarized in a plane passing through the centre of the sun, while that of the prominences was unpolarized. The fact of the polarization discarded the hypothesis, sufficiently improbable on other grounds, that the corona belongs either to our own atmosphere or to a lunar atmosphere (since in that case the light would be reflected or scattered at an almost grazing incidence), and proved it to belong to the sun, and to shine mainly, if not wholly, by reflected light. The absence of polarization in the light of the prominences proved that they are very probably self-luminous. The elaborate photographic observations of Mr. Warren De La Rue on the same eclipse proved, by the motion of the prominences relatively to the moon, that they belong to the sun, and showed that their light is remarkable for its actinic power.

In the interval between this eclipse and that of the present year, a new method of research had sprung up, in the application of the spectroscope to the celestial bodies, and already, in the hands of Mr. Huggins, had revealed in many of the nebulæ a constitution hitherto unsuspected. It was important to apply this method of research to the red prominences. Should they give a continuous spectrum, the conclusion would be that the matter of which they consist is probably in a solid or liquid condition, such as clouds formed by precipitation; should the spectrum be one of bright lines, we must conclude that they are glowing gas.

To solve this important problem, independently of what might be done by other scientific bodies or by individuals, the Royal Society procured an equatorially mounted telescope, furnished with a spectroscope and clock-movement. With the sanction of Colonel Walker, R.E., Director of the Great Trigonometrical Survey of India, this instrument was entrusted to Lieut. John Herschel, R.E., who is attached to the Survey, and who, being at the time in England, had the advantage of instruction from so skilful an observer as Mr. Huggins before his return to India. After his return to India, Lieut. Herschel worked diligently at the spectra of the southern nebulæ, thereby at the same time making an important addition to our knowledge, and practising for the approaching eclipse. Four direct-vision hand-spectroscopes, intended for distribution to observers at different stations, were also sent out,—partly that the occasion might not be

wholly lost in case clouds should prevent observations from being taken at the principal station; partly because a more rough and general view of the whole phenomenon might reveal features which would be missed in a more careful scrutiny of a particular part. Another telescope, furnished with analyzers for the examination of polarization, was also sent out; for from the shortness of the time at the disposal of an observer, it would be satisfactory that the results obtained, even by so skilful an observer as M. Prazmouski, should be confirmed.

The observations of the observers entrusted with these instruments were greatly impeded by flying clouds, notwithstanding which, however, important work was done. With the principal instrument, Lieut. Herschel ascertained that the spectrum of the prominences showed three isolated bright lines—red, orange, and blue. He had time to take a good measure of the position of the orange line, which proved to be coincident with D, as nearly as the instrument could measure. Clouds prevented the measure of the blue line from being equally good; it proved, however, to be nearly coincident with F, apparently a very little less refrangible. With one of the hand-spectroscopes Captain Haig, R.E., observed the spectrum of the red prominences to consist of two bands, "rose-madder" and "golden yellow," corresponding, doubtless, to the "red" and "orange" of Herschel. But besides these, *just before* the emergence of the sun, Capt. Haig observed, "in the spectrum of the moon's edge," two well-defined bright bands, one green and one indigo. The seizing of this almost momentary phenomenon, establishing as it does the existence of a thin envelope of glowing gas (unless, indeed, the constitution thus revealed were merely local, and its occurrence just at the part of the sun first measured were a mere matter of chance), proves the advantage of not neglecting the use of a comparatively rough instrument intended for a general scrutiny of the phenomenon.

Of the remaining hand-spectroscopes, one was entrusted to Mr. Chambers, Director of the Bombay Observatory, but could not be used on account of clouds, and two were placed in the hands of the commanders of homeward-bound steamers, belonging to the Peninsular and Oriental Steam Navigation Company. Capt. Charles G. Perrins, of the 'Carnatic,' who had charge of one, was unable to apply it to the intended observations, as his ship was about 20 miles north of the track of the total phase; with the other, Capt. Rennoldson, of the 'Rangoon,' ascertained the discontinuous character of the red prominences, and his observation would have been very valuable had clouds prevented observations from being taken on shore.

The telescope furnished with analyzers was placed in the hands of Lieut. Campbell, R.E., who has fully confirmed the previous observation of M. Prazmouski relative to the strong polarization of the light of the corona.

A feature of the prominences, which is specially noticed in Capt. Haig's

account, resting on the observations of Capt. Tanner and Mr. Kero Laxuman, who were of his party, is their streaked character. This had been noticed before, in the eclipse of 1860. Mr. Warren De La Rue, in speaking of the prominences, expressly mentions their structure; and M. Chacornac, who devoted himself to this object, has given a long description of their appearance*, which, however, is a little difficult to follow for want of a figure. The strong actinic power, the streaked character, and the bright-line spectrum of the prominences seem certainly to accord very well with the hypothesis in which they are regarded as gigantic auroræ—a view, however, which may be rendered less probable by the apparently general prevalence over the sun's surface of a lower stratum of similar nature, of which the prominences are merely elevated portions.

The great Melbourne Telescope was despatched to its destination in an Australian packet ('The Empress of the Seas'), which sailed from Liverpool on the 18th of July last; and M. Le Sueur proceeded overland to await its arrival. The micrometer and spectroscope which are to follow are quite ready, and the photographic apparatus is also nearly ready, to be despatched to Melbourne.

In June last the President and Council received from Dr. Carpenter and Professor Wyville Thomson letters strongly recommending that the Zoology of the *Deep Sea*, especially in the North Atlantic Ocean, should be more thoroughly and systematically examined than has hitherto been accomplished, and requesting the intervention of the Royal Society with the Admiralty for the purpose of obtaining the services of a vessel, with proper means and appliances for deep-sea sounding and dredging, to carry on a systematic research, in the seas immediately north of our own island, for a month or six weeks in the approaching autumn—and tendering their own services to accompany the vessel.

With the thoroughly efficient aid of the Hydrographer, Capt. Richards, R.N., the 'Lightning,' surveying-ship, Staff-Commander May, was selected and equipped expressly for this service; and Dr. Carpenter and Professor Thomson embarked in her on the 10th of August, at Stornoway. After examining the seas between Scotland and the Färoe Islands, the 'Lightning' returned on the 9th of September to Stornoway, to land Professor Thomson (whose presence was required elsewhere), and sailed again (this time accompanied by Dr. Carpenter only) for a second, more westerly cruise, which lasted until the 26th of September.

A preliminary report of the results has been received from Dr. Carpenter, and will be read to the Society at an early evening meeting in the present session; I will only venture to anticipate the contents of this very valuable report so far as to say that it will be found of very high interest both in respect to the temperature of the sea at great

* Le Verrier's 'Bulletin' for Sept. 4–8, 1860.

depths, and to the nature of the sea-bottom, and the life existing in its vicinity.

The report strongly recommends the continuation and extension of these researches—a recommendation which in due time will require and receive the attention of your Council, who may confidently anticipate that should a further application to the Admiralty be deemed desirable it will receive favourable consideration, and, if approved, will be secure of the same cordial and invaluable cooperation on the part of the Hydrographer as that which has been enjoyed on this occasion.

We have to rejoice in the safe return of the Swedish and North-German Expeditions, engaged in the past summer in the endeavour to extend the domain of Arctic Exploration to the north and to the west. Though the limits previously attained have not been passed in either direction, much valuable information has been obtained regarding the Natural History of Northern Lands, as well as many important facts bearing on the Hydrography of the Arctic Seas; while an experience has been gained in Arctic navigation, and habits acquired of surmounting the difficulties which it presents, that may yield good fruit hereafter.

The Arctic explorations of the Swedes included, from their commencement, the design of accomplishing such a preliminary survey of Spitzbergen as might solve the question of the practicability of the measurement of a degree of the meridian in that high latitude. The idea of such an undertaking having originated in this country and in this Society more than forty years ago, it is natural that we should regard the steps taken towards its accomplishment with a lively sympathy. A sketch of what was effected in 1861 and 1864 by MM. Chydenius, Düner, and Nordenskiöld, communicated to the Royal Society by Captain Skogman, of the Royal Swedish Navy, was printed in the Proceedings of December 1864. An official and elaborate Report has since been published (in Sept. 1866) by the Royal Swedish Academy, entitled "Förberedande Undersökningar rörande Utförbarheten af en Gradmätning pä Spetsbergen" (preliminary researches touching the facilities for a measurement of a degree at Spitzbergen), by MM. Düner and Nordenskiöld (Chydenius having unfortunately died). In the Map accompanying the Report the triangles are laid down which connect the extremes of land, and comprehend an arc of about 4° 11′. One of the objects contemplated by the expedition which has just returned was, to examine the possibility of the extension of the arc to lands existing to the north of the north-easternmost part of Spitzbergen—a question, however, which cannot be regarded as yet perfectly solved, the northern progress of the 'Sophia' having been stopped by ice, which is described by M. Nordenskiöld as "consisting in part of fields of drift-ice, covered with particles of earth, which seems to indicate that land is to be met with further north."

Should these preliminary researches and surveys eventuate in a Scandi-

navian arc-measurement at Spitzbergen, I need scarcely say with what interest such an undertaking would be regarded by this country and by its Royal Society.

With reference to the operations of the Committee, appointed at the Nottingham Meeting of the British Association, for the Exploration of the Tertiary Plant-beds of North Greenland, it was stated in my last Address that a large collection of fossil plant-remains had been brought from Greenland by Mr. Edward Whymper.

The entire collection has been sent, for examination and description, to Prof. Oswald Heer, of Zurich, who has already published a work, 'Flora Fossilis Arctica,' containing the results of his examination of the fossils brought at various times from Greenland and other parts of the arctic regions and deposited in the museums of this country and of Denmark and Sweden.

The Committee, finding that their funds were exhausted, made a fresh application to the Government-Grant Committee, and received an additional sum to defray the expense of carriage of the specimens to and from Zurich.

The collection was forwarded to Switzerland at the end of last year; and within the last week Prof. Heer has sent the description of the fossils to London, with the view of submitting it to the Royal Society.

The localities which were examined by Mr. Whymper were situated on the shores of the Waigat, at two points on Disco Island, and at Atanekerdluk, on the mainland of Greenland.

From Disco, whence specimens had only once been obtained before (by Dr. Lyall), 14 species were procured. Among them the occurrence of two cones of *Magnolia* present the greatest interest, as they prove to us that an evergreen, such as *Magnolia*, could ripen its fruit at the high north latitude of 70°.

The collection from Atanekerdluk is especially rich, but this locality was well known before; the number of species from it in this collection is 73. Among the most important of these are the flowers and fruit of a *Chestnut*, proving to us that the deposits which contain them must have been formed at different seasons, corresponding to the times of flowering and fruit of the Chestnut.

The collection is not rich in animal remains; however, some insects have been noticed, as well as a freshwater bivalve, probably "*Cyclas*."

The results of this expedition have been eminently satisfactory, whether we look to the number of new species discovered, or to the additional facts, confirmatory of previous determinations, which have been ascertained. This latter remark is of special importance when we find that the identification of a tree by means of its leaves has been supported by the subsequent discovery of its flowers and fruit.

The number of fossil species of vegetable remains discovered in Green-

land has increased to 137, of which 46, or exactly one-third, belong to it in common with the Miocene deposits of Europe.

Four of these are found in our own Bovey Tracey beds, which have been already described by Prof. Heer in the 'Philosophical Transactions.' Among these is *Sequoia Couttsiæ*, the commonest tree in the British locality. Accordingly the age of the Greenland deposits has been fixed beyond a doubt as Lower Miocene.

The collection itself is expected to arrive in London shortly, when a complete series of the specimens will be deposited in the British Museum, in accordance with the terms prescribed by the British Association and the Government-Grant Committee of the Royal Society.

The redaction of the great scientific work, the Magnetic Survey of the South Polar Regions—commenced in 1839, under the auspices and at the expense of Her Majesty's Government—has been completed in the present year by the presentation to the Royal Society, and the publication in the Philosophical Transactions, of Maps of the three Magnetic Elements in Southern Parallels, commencing in 30° south, and extending far beyond the limits of ordinary navigation. These Maps are accompanied by Tables containing the numerical coefficients to be employed in a revision of 'Gauss's General Theory,' at the intersection of every fifth degree of latitude and every tenth degree of longitude, between 30° south latitude and the south terrestrial pole. The magnetical determinations of the Survey correspond to the epoch $1842\frac{1}{2}$. Similar Maps for the corresponding latitudes of the Northern Hemisphere, from 30° north latitude to the north terrestrial pole, are in preparation, founded on a coordination of results obtained by magneticians of all countries in the fifteen years preceding and the fifteen years following the same mean epoch of $1842\frac{1}{2}$, and reduced to it. It is hoped that these Maps, with an accompanying Memoir, will be presented to the Royal Society before the close of the present session. There will then remain for subsequent completion the filling up (still for the same epoch) of the space between the parallels of 30° north and 30° south latitude, for which much preparation has been made in the assemblage of materials, requiring only, for their coordination, the allotment of the time needed for the due examination and treatment of so large a body of materials. Should I be so happy as to be able to complete this task also, (my occupation in Terrestrial Magnetism has now extended, more or less, over half a century,) I venture to express a hope that the great work of which the foundation will thus have been laid, viz. "the Revision of the Gaussian Theory, corresponding to a definite epoch in the great cycle of terrestrial magnetism," may, when a suitable time shall appear to have arrived, be taken up and completed under the auspices of the Royal Society.

Whilst on the subject of Terrestrial Magnetism, I may remark that, in a recent number of his 'Wochenberichte,' Dr. Lamont has called the

attention of magneticians to the probable occurrence of the epoch of maximum of the magnetic disturbances at the end of the present year 1868, in accordance with the hypothesis of a decennial period, and has noticed the already great increase in the number of days of unusual magnetic disturbance observed at Munich in the months of August, September, and October last. Coincidently with Dr. Lamont's experience in this respect, the continuous records of the magnetometers at Kew have shown larger and more frequent magnetic disturbances than usual; and the Photoheliographs, taken there on all days when the sun is visible, have shown larger and more numerous groups of sun-spots.

It may be worthy of remark in this connexion, that 1868 is the fourth decennium since the occurrence of the first well-ascertained maximum of magnetic disturbance; I mean that which, resting on the authority of Arago's admirable and systematic series of observations (1821–1830), has been shown to have taken place in 1828 *. It may be proper, however, to await the more decisive evidence which the years 1873 to 1879 may afford, as to the preference to be given to either of the periods assigned by different magneticians (respectively 10 and $11\frac{1}{11}$ years) as the duration of this remarkable phenomenon, which appears to attest the simultaneity of physical affections of the sun and of the earth. If the *decennial* hypothesis be correct, 1873 will be the year of minimum, and 1878 that of maximum; if, on the other hand, the period be one of 11 years and a small fraction, 1873 should be the year of maximum, and 1878 the year of minimum; and the order of progression and sequence be reversed.

I mentioned in my last year's Address that the operations of the Bombay Observatory were delayed by the non-reception of the necessary self-recording magnetical and meteorological instruments of the best modern construction. I am glad to be able to state on this occasion that a communication which I ventured to make to Sir Stafford Northcote, Secretary of State for India, had the immediate effect of removing the difficulty which had intervened, and that advice has recently been received of the safe arrival of these instruments at Bombay. We may now confidently anticipate that, under the able and zealous superintendence of Mr. Chambers, the Bombay Observatory will speedily take a place in the first rank of institutions specially devoted to these two branches of Physical Science.

A paper of considerable interest and importance, entitled "Scientific Exploration of Central Australia," was presented to the Society in April last. The geographical and scientific researches of its author, Dr. Neumayer, published under the authority of the Victorian Government, attest his competency to discuss a subject of this magnitude in its various points of view. The paper itself is an able and interesting one; it contains the

* Arago, Meteor. Essays, English Translation, Longman, 1855. Editor's Note, pp. 355–357.

outline of a large and apparently well-considered scheme, with estimates and other essential details; it contemplates an expedition to last three or four years, starting from the eastern shores of Queensland, and terminating in an exploration of the western portion of the Australian continent; and he offers his own services for the conduct of such an undertaking. Should the plan find favour with the different Australian Colonies who would bear its expense and reap the chief material advantage of its results, there can be no doubt of its producing a rich harvest in physical geography and natural history, and as little doubt of the warm interest it would command in the Scientific Societies of the mother country, especially in the Royal Society, and of the pleasure with which they would give to it every assistance in their power.

I proceed to the award of the Medals.

The Copley Medal has been awarded to Sir Charles Wheatstone, F.R.S., for his researches in Acoustics, Optics, Electricity, and Magnetism.

The researches of Sir Charles Wheatstone in acoustics, optics, electricity, and magnetism, numerous and important as they are, have already taken their place as integral parts of science, and have become so completely incorporated into its teaching that it will be hardly necessary on the present occasion to do more than enumerate the leading ones, in recognition of which the Copley Medal has this year been awarded.

The earliest of these researches in point of time were those connected with acoustics; and among these we may mention a paper on the transmission of sound through solid conductors, which (in 1828) describes the means discovered by the author of transmitting musical performances to distant places, where they are made audible by sounding-boards through the intervention of wires or wooden rods.

His paper on the acoustic figures of vibrating surfaces was published in the 'Philosophical Transactions' for 1832. In this the laws of the formation of the varied and beautiful figures discovered by Chladni were first traced.

His subsequent invention of the Kaleidophone furnished him with an elegant means of showing optically the coexistence of different forms of vibrations in sounding bodies.

His wave-machine furnished a still more complete method of demonstrating the composition of undulations by mechanical means.

In optics his contrivance of the Stereoscope and the Pseudoscope, and his discussion of the modes in which binocular vision is effected, described in the 'Philosophical Transactions' for 1838 and 1852, were even more ingenious and important, as showing us how we obtain a perception of solidity or relief, or of its reverse, by the simultaneous observation of two plane images.

Another ingenious optical invention was the Polar Clock, described to the British Association at their Meeting in 1849. This is an instrument

which indicates the time by means of the changes of polarization of the blue light of the sky in the direction of the pole, founded on the discoveries of Arago and Quetelet.

In 1835 he communicated to the British Association a paper on the Prismatic Analysis of the Electric Light, proving that the electric spark from different metals presents for each a different spectrum, exhibiting a definite series of lines, differing in position and colour from each other, and thus enabling very small fragments of one metal to be distinguished with certainty from all the others. This was a starting-point in a new and fertile field of physical inquiry which has abundantly rewarded the labours of subsequent investigators.

But no series of his researches have shown more originality and ingenuity than those by which he succeeded in measuring the velocity of the electric current and the duration of the spark. The principle of the rotating mirror employed in these experiments, and by which he was enabled to measure time to the millionth part of a second, admits of application in ways so varied and important that it may be regarded as having placed a new instrument of research in the hands of those employed in delicate physical inquiries of this order.

Scarcely less valuable are the instruments and processes which Sir Ch. Wheatstone devised for determining the constants of a voltaic circuit, including, among others, the rheostat and the differential resistance measurer (or Wheatstone's bridge, as it is usually called), which, in one or other of its modifications, is become an indispensable means of measuring the resistance of telegraphic wires and cables, as well as for determining electromotive forces. The description of these methods is contained in a paper in the 'Philosophical Transactions' for 1843.

But it is with the Electric Telegraph that the name of Sir C. Wheatstone is in the public mind most completely identified; and ever since the first messages were transmitted along the Great Western Railway by insulated copper wires enclosed in iron tubes, to the present day—when a network of copper wires insulated by means of caoutchouc is suspended across our public thoroughfares for the instantaneous transmission of intelligence, not merely from one district to another in our large towns, but from one continent and capital to another—Sir C. Wheatstone has not ceased to contribute the most important aid towards perfecting the means of electro-telegraphic communication.

A bare enumeration of these various inventions would carry us beyond our limits on the present occasion. In 1840 he devised a cable adapted for transmitting intelligence under the sea; and it is to him that we are indebted for the Alphabetic Dial Telegraph working without any clock-power, and in which a magneto-electric machine supplies the place of a voltaic battery. These instruments were first used in the Paris and Versailles Railway in 1846.

A more recent invention is his High-Speed Telegraph, in which the

messages, previously prepared on slips of paper, are, by passing through a very small machine constructed somewhat on the principle of the Jacquard Loom, made to print the messages at the remote station, in the ordinary telegraphic characters, with a rapidity unattainable by the hand of an operator.

Allied to these inventions are others where electro-magnetism is the motive power, as, for example, the electro-magnetic clock for telegraphing time, a modification of which has since been employed to aid in determining the longitude of distant places; also the Chronoscope, for measuring the velocity of projectiles or falling bodies.

In this enumeration of his discoveries, inventions, and researches, we have passed over many, such as his speaking machine, the investigation of Fessel's Gyroscope, his experiments in illustration of Foucault's proof of the rotation of the earth, and others.

More than enough, however, has been stated to justify the presentation of the Copley Medal on this occasion to our eminent fellow-countryman.

Sir Charles Wheatstone,

I have the very agreeable duty of presenting to you this Medal, which you will receive as a testimony of the sense so universally entertained by your countrymen, and specially by the Fellows of the Royal Society, of the high scientific merit and practical value of your many discoveries and inventions, and of their varied applications.

The Council has awarded a Royal Medal to the Rev. Dr. George Salmon, Regius Professor of Divinity in the University of Dublin, for his original investigations on Analytical Geometry, published in the Transactions of the Royal Irish Academy and in the Philosophical Transactions,—and, specially, for his solution of the problem of the degree of a surface reciprocal to a given surface—and for his researches in connexion with surfaces subject to given conditions, analogous to those of Chasles in plane curves.

Besides the original investigations thus referred to, Dr. Salmon is the author of a series of works on Conic Sections, on higher Plane Curves, on Geometry of Three Dimensions, and on higher Algebra (the modern Analysis), full of original matter of great value to the advanced mathematician, and at the same time adapted to the requirements of the student. These works have become widely spread as text-books throughout Europe; and the estimation in which they are held is attested by the fact that they have already been translated into French, German, Italian, and Russian.

Dr. Salmon,

I have the pleasure of presenting you this Medal in testimony of the

high estimation in which your attainments and labours in the higher branches of mathematics are held by the Royal Society.

A Royal Medal has been awarded to Mr. Alfred Russell Wallace, in recognition of the value of his many contributions to theoretical and practical zoology, among which his discussion of the conditions which have determined the distribution of animals in the Malay archipelago (in a paper on the zoological geography of that region, published in the Proceedings of the Linnean Society for 1859) occupies a prominent place.

The case may be briefly stated thus:—The strait separating the islands of Baly and Lembok is only fifteen miles wide; nevertheless the animal inhabitants of the islands are widely different, the fauna of the western island being substantially Indian, that of the eastern as distinctly Australian.

Mr. Wallace has described, in a far more definite and complete manner than any previous observer, the physical and biological characters of the two regions which come into contact in the Malay archipelago; he has given an exceedingly ingenious and probable solution of the difficulties of the problem, while his method of discussing it may serve as a model to future workers in the same field.

Another remarkable essay, "On the tendency of Varieties to depart indefinitely from the Original Types," published in the Proceedings of the Linnean Society for 1858, contains an excellent statement of the doctrine of Natural Selection, which the author, then travelling in the Malay archipelago, had developed independently of Mr. Darwin; and, apart from its intrinsic merits, this paper will always possess an especial interest in the history of science, as having been the immediate cause of the publication of the 'Origin of Species.'

Mr. Wallace's ability as an observer and describer of animal forms is shown in his numerous and valuable contributions to our knowledge of the animals, and especially the Pigeons, Parrots, and Butterflies, of the Malayan region.

It must not be forgotten that a knowledge of the circumstances under which the majority of these contributions to the higher branches of zoological science were made must greatly enhance our respect for the author. Mr. Wallace has spent the greater part of his life amidst the exhausting and often dangerous fatigues of a traveller in tropical countries rarely explored by Europeans; and some of his most valuable papers are dated from places which some might consider so little favourable to study as Ternate and Sarawak.

Mr. Wallace,

I have the pleasure of presenting to you this Medal in recognition of the great merit of your researches both in practical and theoretical Zoology, carried out in countries where such pursuits are necessarily attended with more than usual difficulties and dangers.

The Rumford Medal has been awarded to Mr. Balfour Stewart, for his researches on the qualitative as well as quantitative relations between the powers of emission and absorption of bodies for heat and light, published originally in the Transactions of the Royal Society of Edinburgh and in the Proceedings of the Royal Society of London, and now made more generally accessible by the publication, in 1866, of his treatise on heat.

When a body is placed within an opaque envelope which is kept at a constant temperature, it soon acquires the temperature of the envelope—and that, whatever be the nature or form of the envelope or of the body. The same is true if any number of bodies of different kinds be placed within the envelope; in the permanent state each of the bodies attains a fixed temperature, the same as that of the walls of the envelope. The equilibrium of temperature is not, however, of the nature of statical equilibrium; according to the theory by which Prevost so beautifully explained the apparent radiation of cold, each body radiates heat all the while, at a rate depending only on its nature and temperature, and not at all on its environment; and it is because the other bodies and the envelope are also radiating heat, and the first body absorbs a portion of the radiant heat thus falling upon it, that its temperature remains unchanged. The equality of radiation and absorption follows as a simple corollary.

It had long been known that rock-salt is remarkable for its transparency for obscure radiant heat. According to Melloni, a plate of rock-salt of the thickness of three or four millimetres transmits 92 per cent. of heat-rays from whatever source. Now, on measuring by the thermopile the radiation from thin and thick plates of rock-salt, as well as from two or more plates placed one behind the other, all being heated up to a definite temperature, Mr. Stewart found that the radiation from a thick plate, or from many plates, was, indeed, greater than from a thin plate or from a single plate, but that the difference was not by any means so great as it ought to have been on the supposition that the heat radiated by the hinder portion of a thick plate, or by the hinder plates of a group, passed through the front portion of a thick plate, or through the front plate of a group, as freely as obscure heat would have passed which was radiated by lampblack or most other substances. It thus appeared that rock-salt at any temperature is by no means transparent to heat radiated by rock-salt of the same temperature—that it exerts a preferential absorption on rays of the quality of those which it emits. This conclusion was confirmed by using a plate of cold rock-salt as a screen by which to sift the heat-rays falling on the thermopile. It was found that a much larger proportion of the heat was stopped by the screen when the source of heat was a plate of heated rock-salt than when it was a body coated with lampblack. The proportion stopped was also sensibly greater when the source of heat was a thin than when it was a thick plate of rock-salt, the reason being that the heat radiated from the hinder portion of a thick plate was partially sifted, in passing across the front portion, before it reached the rock-salt

screen, and therefore was transmitted by it in greater proportion than the heat which radiated from the front portion.

Similar conclusions were obtained from experiments on glass and mica, though the numerical results were not so striking, in consequence of the comparatively great opacity of those substances for obscure radiant heat.

It thus appeared, 1st, that the heat radiated by a body is not confined to that which comes from the immediate neighbourhood of the surface, but emanates from various, in the case of rock-salt considerable, depths; 2ndly, that there is a relation between the quality of the heat radiated and that absorbed by any given element of a body, and consequently by a sufficiently thin plate of a body, of such a nature that the kind of heat most freely radiated is also most freely absorbed.

These results and others were comprehended by Mr. Stewart in a definite theory, by means of his extension of Prevost's theory of exchanges. According to this extension, the stream of radiant heat within a uniformly heated enclosure is the same throughout in *quality* as well as quantity; *i. e.* the uniformity of radiation exists for *each kind of heat in particular* of which the total flux is made up.

Few now can doubt the identity of nature of radiant heat and light; and, accordingly, the application to light of the extension of Prevost's theory was an obvious step. This step was taken by Mr. Stewart, who verified by experiment that which theory predicted—that a coloured glass when heated, as compared with an opaque body glowing at the same temperature, gives out by preference rays of the kind which it absorbs, and consequently tends to glow with a colour complementary to its own. For a similar reason a plate of tourmaline cut parallel to the axis, when heated, and viewed in a direction perpendicular to the axis, is seen to glow with light which is partially polarized in a plane parallel to the axis.

It is right to mention that, in regard to the extension of Prevost's theory in its application to light, Mr. Stewart was slightly anticipated by Professor Kirchhoff, whose brilliant application of the theory to the lines of the spectrum has attracted general attention, whose researches, however, had hardly, if at all, reached this country when Mr. Stewart's papers were presented. As regards Radiation, however, without specifying of what kind, the priority in the extension of Prevost's theory belongs to Mr. Stewart, whose papers on Heat were published before those of Professor Kirchhoff, to whom, however, they were not known when he published his earlier papers.

Mr. Stewart,

I have particular pleasure in presenting to you this Medal, because it will testify to you that all that really conduces to the advance of our knowledge meets sooner or later with its due recognition—and because I hope that this tribute to your earlier labours will be especially agreeable to you now that you are engaged in work of high public value, but which must necessarily leave you little leisure for such original researches.

On the motion of Sir Charles Lyell, seconded by Sir Thomas Watson, it was resolved,—"That the thanks of the Society be returned to the President for his Address, and that he be requested to allow it to be printed."

The Statutes relating to the election of Council and Officers having been read, and Sir Edwin Pearson and Mr. Erasmus Wilson having been, with the consent of the Society, nominated Scrutators, the votes of the Fellows present were collected, and the following were declared duly elected as Council and Officers for the ensuing year :—

President.—Lieut.-General Sabine, R.A., D.C.L., LL.D.

Treasurer.—William Allen Miller, M.D., D.C.L., LL.D.

Secretaries.— { William Sharpey, M.D., LL.D.
George Gabriel Stokes, Esq., M.A., D.C.L., LL.D.

Foreign Secretary.—Prof. William Hallows Miller, M.A., LL.D.

Other Members of the Council.—Frederick Augustus Abel, Esq.; Sir Benjamin Collins Brodie, Bart., M.A.; William Benjamin Carpenter, M.D.; J. Lockhart Clarke, Esq.; Frederick Currey, Esq., M.A.; Warren De La Rue, Esq., Ph.D.; Sir William Fergusson, Bart.; William Henry Flower, Esq.; Capt. Douglas Galton, C.B.; John Peter Gassiot, Esq.; John Hawkshaw, Esq.; John Marshall, Esq.; Joseph Prestwich, Esq.; George Henry Richards, Capt. R.N.; Archibald Smith, Esq., M.A.; Lieut.-Col. Alexander Strange.

Receipts and Payments of the Royal Society between December 1, 1867, and November 30, 1868.

	£	s.	d.
Balance at Bank and on hand	495	10	3
Annual Subscriptions, Admission Fees, and Compositions	1585	4	0
Rents	251	5	0
Dividends	1455	6	7
Ditto, Trust Funds	280	12	4
Sale of Transactions, Proceedings, &c.	371	0	1
Repayments	341	7	8
	£4780	5	11

	£	s.	d.	£	s.	d.
Salaries, Wages, and Pension				1037	6	0
The Scientific Catalogue				342	15	0
Instruments for India and freight				293	5	0
Books for the Library and Binding				219	9	0
Printing Transactions and Proceedings, Paper, Binding, Engraving, and Lithography				1651	13	10
General Expenses (as per Table subjoined)				355	2	9
Donation Fund	335	0	0			
Wintringham Fund	35	5	0			
Copley Medal Fund	4	14	10	386	19	10
Prof. Roscoe, Bakerian Lecture	4	0	0			
Rev. Dr. Stebbing, Fairchild Lecture	2	19	0			
Croonian Lecture, Poor of St. James' Parish	2	19	0			
Mablethorpe Schools, Donation	2	2	0			
				4286	11	5
Balance at Bank	479	16	1			
Balance of Catalogue Account	12	2	3	493	14	6
,, Petty Cash Account	1	16	2			
				£4780	5	11

WILLIAM ALLEN MILLER,
Treasurer.

Estates and Property of the Royal Society, including Trust Funds.

Estate at Mablethorpe, Lincolnshire (55 A. 2 R. 2 P.), £126 per annum.
Estate at Acton, Middlesex (34 A. 2 R. 27½ P.), £109 per annum.
Fee Farm near Lewes, Sussex, rent £19 4*s.* per annum.
One-fifth of the clear rent of an estate at Lambeth Hill, from the College of Physicians. £3 per annum.
£14,000 Reduced 3 per Cent. Annuities.
£29,569 15*s.* 7*d.* Consolidated Bank Annuities.
£513 9*s.* 8*d.* New 2½ per Cent. Stock—Bakerian and Copley Medal Fund.

Scientific Relief Fund.

Investments up to July 1865, New 3 per Cent. Annuities £6052 17 8

£6052 17 8

Dr. *Cr.*

	£	s.	d.
Balance	197	6	0
Donation	5	0	0
Dividends	177	1	0
	£379	7	0

Statement of Income and Expenditure (apart from Trust Funds) during the Year ending November 30, 1868.

	£	s.	d.
Annual Subscriptions	1049	4	0
Admission Fees	160	0	0
Compositions	376	0	0
Rents	251	5	0
Dividends on Stock (exclusive of Trust Funds)	1006	6	2
„ on Stevenson Bequest	449	0	5
Sale of Transactions, Proceedings, &c.	371	0	1
Cost of Instruments, repaid	284	18	6
Chemical Society, Tea Expenses £18 0 0			
Linnean Society, Tea Expenses 14 0 0	32	0	0
Geographical Society, Gas at Evening Meetings 8 4 8			
Cambridge Local Examination Committee, Gas 3 12 0	11	16	8
Sundry Petty Receipts	12	12	6
Income available for the Year ending Nov. 30, 1868	4004	3	4
Expenditure in the Year ending Nov. 30, 1868	3899	11	7
Excess of Income over Expenditure in the Year ending Nov. 30, 1868	£104	11	9

				£	s.	d.
Salaries, Wages, and Pension				1037	6	0
The Scientific Catalogue				342	15	0
Instruments for India and freight				293	5	0
Books for the Library				122	11	3
Binding ditto				96	17	9
Printing Transactions, Part II. 1867, and Part I. 1868	409	8	6			
Ditto Proceedings, Nos. 96–104	289	18	6			
Ditto Miscellaneous	68	6	5	1651	13	10
Paper for Transactions and Proceedings	311	4	6			
Binding and Stitching ditto	92	10	9			
Engraving and Lithography	480	5	2			
Fittings, Cleaning, and Repairs				45	4	4
Miscellaneous Expenses				37	10	6
Coal, Lighting, &c.				130	7	3
Tea Expenses				54	14	11
Fire Insurance				28	11	6
Taxes				10	11	3
Advertising				12	10	6
Postage, Parcels, and Petty Charges				35	12	6
				£3899	11	7

WILLIAM ALLEN MILLER, *Treasurer.*

The following Table shows the progress and present state of the Society with respect to the number of Fellows:—

	Patron and Royal.	Foreign.	Com-pounders.	£2 12s. yearly.	£4 yearly.	Total.
November 30, 1867.	5	48	298	2	264	617
Since elected		+4	+7		+9	+20
Since re-admitted ..					+1	+1
Since compounded..			+1		−1	
Since deceased	−1	−4	−17		−12	−34
Since withdrawn ..					−1	−1
Defaulters					−3	
November 30, 1868.	4	48	289	2	257	600